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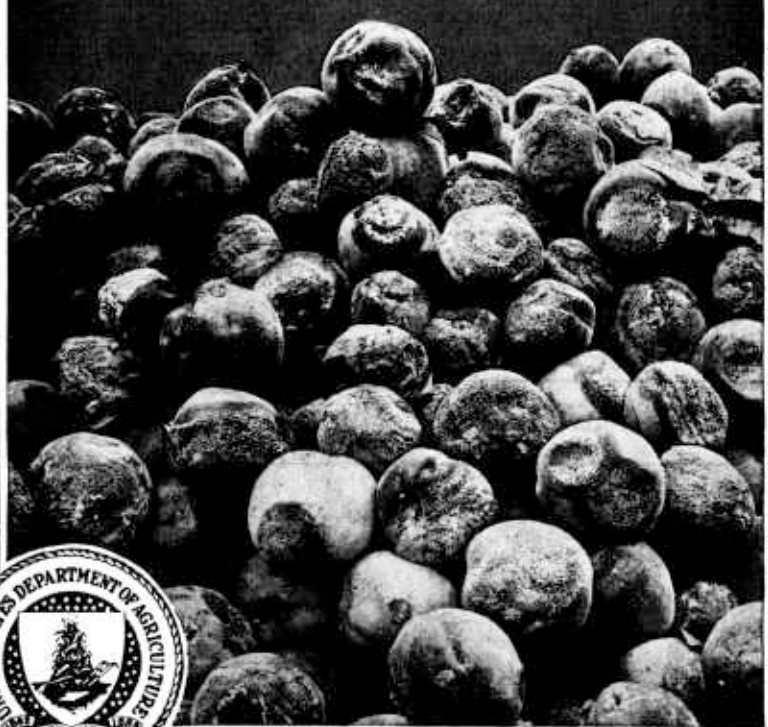
PEACH BROWN ROT & SCAB



BROWN ROT AND SCAB, diseases of the peach caused by two different species of fungi, annually cause heavy losses in practically all sections of the eastern half of the United States in which peaches are grown. Fruit, twigs, and leaves may be affected by these diseases, but the chief injury is to the fruit. The fungi causing scab and brown rot are able to penetrate the unbroken epidermis of the fruits, but the fungus causing brown rot enters more readily through wounds, and particularly through punctures made by the curculio or peach worm.

Brown rot, scab, and curculio can be controlled by spraying or dusting. Directions for the application of sprays and dusts, together with formulas and methods for making up the various spray fluids and dusts, are given in this bulletin. Removal of sources of infection is useful as a supplemental measure in the control of brown rot.

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PEACH BROWN ROT AND SCAB

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DISTRIBUTION AND ECONOMIC IMPORTANCE

BROWN ROT (the common rot of the peach), caused by the fungus *Sclerotinia fructicola* (Winter) Rehm., and scab or "black spot", caused by the fungus *Cladosporium carpophilum* Thüm., are linked together in this bulletin because they have somewhat the same distribution and because both are controlled by spraying or dusting during the growing season. Probably both diseases occur to some extent wherever the peach is grown.

These diseases are of particular importance in the eastern half of the United States, in the more humid sections of which they cause large losses nearly every year. Because they are favored by nearly the same conditions, they are usually found together, but in certain sections one may be more serious than the other. For example, in central Georgia brown rot is much more destructive than scab, whereas in parts of the Appalachian highland scab is regularly the more destructive. Brown rot has frequently caused practically complete loss of the crop over entire sections devoted to the growing of peaches, while scab seldom causes such loss even in individual orchards. Brown rot develops rapidly, often taking the grower unawares, and is not only an orchard disease but is also the most common cause of losses in transit and on the market. Scab develops slowly, and new infections on the harvested fruit are not important. Previous to 1910, before spraying for the control of brown rot and scab became a general practice, the annual losses were proportionately greater than in later years.

BROWN ROT

The disease generally known as brown rot or monilia rot is the common rot of peaches, plums, or other stone fruits and is well known to both growers and consumers of peaches. It is caused by the fungus *Sclerotinia fructicola* (Winter) Rehm. Brown rot is not

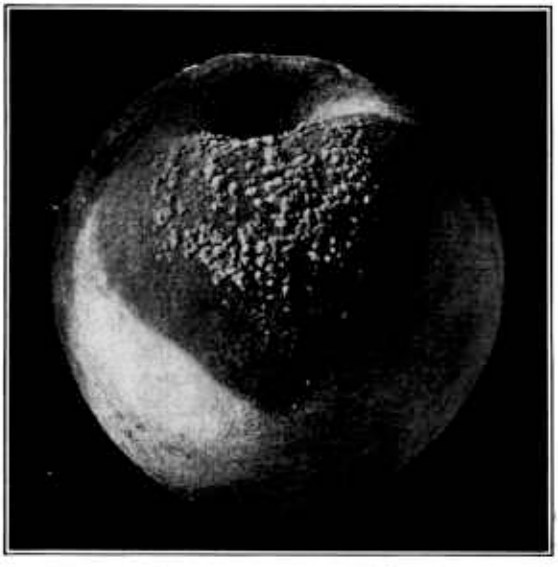

FIGURE 1.—Brown rot of peach, showing masses of spores (conidia).

a common rot of apples, pears, or other pome fruits in the United States. The same or a very similar disease probably occurs in all parts of the world in which the peach is grown.

The name "brown rot" describes the disease as it occurs on the fruit of the peach (fig. 1). It is first visible as a tiny brown speck, which develops rapidly and penetrates deeply into the flesh. The whole peach may be involved and finally may shrink into a hard, brown "mummy" (fig. 2). After the rot has attained some size, and especially after the whole fruit is involved, masses of spores (conidia) are produced on the surface of the rot (figs. 1 and 2). These grayish masses, easily discernible to the naked eye, on drying break up to form the fine dust which one finds on his hands after handling rotten peaches.

If the "mummied" fruits are left on the tree the fungus may grow through the stem of the peach and into the twig, causing a canker or killing the twig by girdling it.

The fungus causing the brown rot of the fruit may also cause a disease of the blossoms. In this phase of the disease, commonly known as blossom blight, the infected blossoms quickly turn brown and die. The dead blossoms adhere to the twig, frequently throughout the season (fig. 3). The disease often progresses from the blossoms into the

FIGURE 2.—Mummied fruits producing spores (conidia) of the brown-rot fungus.

adjacent leaves, causing them to turn brown and die; also into the twigs, causing small cankers or killing the twigs by girdling them (fig. 3). On the surfaces of the dead parts gray masses of spores are soon produced in great abundance. Except in a few restricted districts where the weather at blossoming time is regularly very humid, blossom blight does not usually cause much direct loss. It is of importance, however, because the spores produced on the blighted blossoms and the accompanying cankers may serve as sources of infection for the ripening fruit.

FIGURE 3.—A peach twig showing blossom blight, twig cankers, and killing of the tip, all caused by the brown-rot fungus.

Brown rot sometimes occurs on leaves adjacent to diseased blossoms and fruits. It may also occur on leaves which have been injured by other agencies. As a disease of the foliage, however, it is not important.

The fungus causing brown rot may pass the winter in the mummied fruits hanging on the trees or lying on the ground. On these during the following season spores may be formed, which carry the disease to the blossoms, twigs, and fruits of that season. In addition to producing the spores commonly found, the mummies on the ground—particularly the half-buried ones—often produce goblet-shaped fruiting bodies (apothecia) which shoot into the air another kind of spores (ascospores) (figs. 4 and 5). The goblet-shaped fruiting bodies grow out from horny coverings (sclerotia) with which the fungus invests the mummies, and the period of their production corresponds very closely with the blossoming period of the trees. Mummies of any age may produce these fruiting bodies, but most of them are from mummies 1 and 2 years old. From these fruiting bodies spores are shot out in quantities so large that the mass resembles a cloud of dust. It is believed that most of the blossom infections are caused by these spores. Spores of the other sort are also capable of causing blossom blight, but they seem not to be present at blossoming time in such large numbers as are those produced by the goblet-shaped fruiting bodies.

The spores formed on the blighted blossoms and on the ensuing twig cankers serve to carry the disease along to the ripening fruit. When there are many blighted blossoms it is certain that there will be an abundance of spores scattered about to infect the fruit if conditions are otherwise favorable. In like manner the rotted fruits of early varieties of the peach, many of which are worthless even

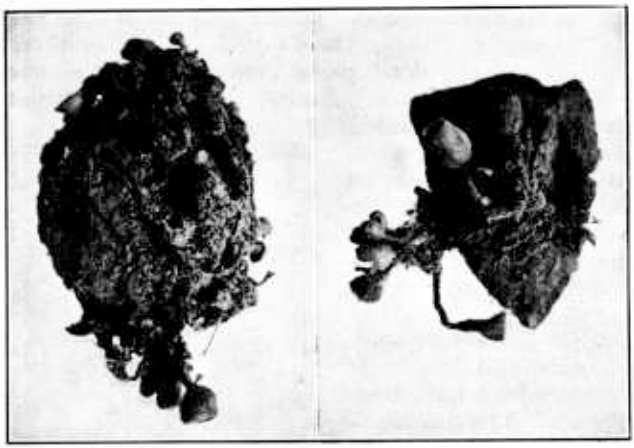

FIGURE 4.—Mummied peaches producing the goblet-shaped fruiting bodies (apothecia) of the brown-rot fungus.

when producing sound fruit, and the rotted fruits of neglected and usually worthless seedlings help to carry the disease along to fruits of more valuable varieties.

The fungus causing brown rot is able to penetrate the unbroken skin of the peach, but when weather conditions are not especially favorable to the disease it more commonly enters through wounds and particularly through the punctures made by the plum curculio or peach worm. Control of the curculio is therefore an important step in the control of brown rot.

Development and rapid growth of the fungus is favored by moderate temperatures (70°–80° F.) and cloudy, rainy, or otherwise humid weather. The watery fruits of a rainy season are more susceptible to its attacks than the more solid fruits of the drier seasons.

Although all the varieties of the peach are more or less susceptible to brown rot, those commonly met with on the markets belong to the less susceptible class. They have taken the places of many of the older and often better-flavored varieties, partly because they do not so readily succumb to brown rot in the orchard, in transit, and on the market. Because of differences in ripening seasons, it is impossible to classify varieties as to their relative susceptibility, since in the same season the conditions

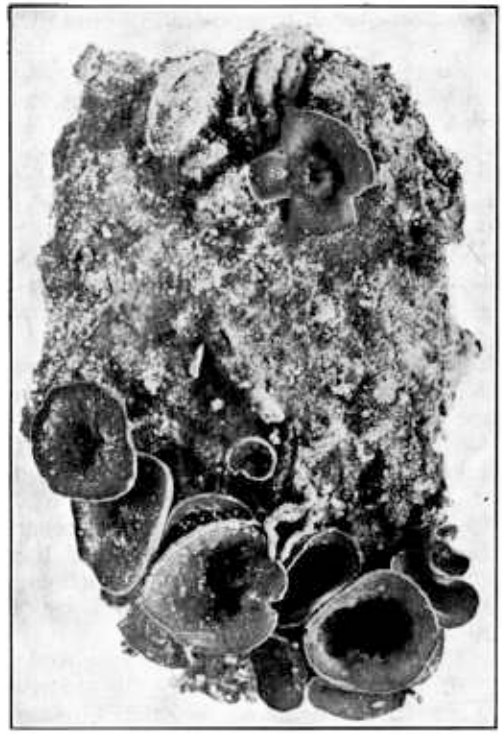

FIGURE 5.—Mummied peach with goblet-shaped fruiting bodies (apothecia) of the brown-rot fungus. (Enlarged about 3 diameters.)

at the time of ripening of one variety may be very favorable to brown rot and at that of another variety very unfavorable. It is, however, well known that such varieties as Champion and Triumph are much more susceptible than Carman, Hiley, Belle, Elberta, J. H. Hale, and other commercial varieties of the present time.

It is considered good practice to prune the tree to an open head and to thin the branches enough to allow sunlight and air to penetrate the tree.

SCAB

In most of the sections of the eastern United States in which peaches are grown, scab, also known as black spot or freckle, is a serious disease. In commercial orchards it is not feared so much as formerly, for the reason that it can be easily and successfully controlled by spraying or dusting. Except in the driest regions, scab probably occurs wherever peaches are grown throughout the world. It is favored by moist weather and moderate temperatures during the growing season. It is more liable to be serious in orchards in low, moist situations than in those having good air drainage.

FIGURE 6.—Scab spots on peach.

Scab is a disease caused by the fungus *Cladosporium carpophilum*. It occurs on other stone fruits, such as the plum and the cherry, as well as on the peach, but it is of little importance except on the peach.

It occurs on the fruit, twigs, and leaves of the peach, but causes little damage to either twigs or leaves. It is, however, carried over from season to season principally in the tiny cankers on young twigs.

On the fruit, usually about the stem end, small circular spots one-sixteenth to one-eighth of an inch in diameter are formed (fig. 6). At first these spots are rather faintly greenish and rather poorly defined. Later they become olive green to black, with well-defined borders. Frequently the spots are so numerous that they run together, forming a large black scablike covering over as much as one-half the surface of the fruit. The name "freckle" appropriately describes typical spots which have not run together (fig. 6). The scabby area frequently splits open, leaving a place for the entrance of brown-rot spores. Peaches with many infections of scab not only crack open, sometimes as far as the pit, but are usually much reduced in size and fail to fill out to the desired plumpness.

In extreme cases the fruit may be so small and misshapen as to be worthless. The infections, being nearly always about the stem of the fruit, frequently cause the fruit to drop prematurely by killing the tissues about the point of attachment of the stem. The killing of these tissues, resulting in the loosening of the stem, is probably

responsible for cutting off the supply of water and nutrients, thus resulting in the small size, lack of plumpness, and inferior flavor of badly scabbed peaches. Spores formed in the diseased areas are capable of causing new spots on the same peach and on other peaches.

On the tender green twigs of the current season the disease appears as small, brown, oval spots or cankers, often with purplish borders. These tiny cankers, seldom more than one-eighth of an inch long, extend only slightly beneath the surface and accordingly cause little injury. They are of importance in that they serve to keep the fungus alive during the winter and thus produce during the following spring the spores which infect the new crop of fruit. During their second year the cankers begin to disappear and cease to be of importance.

Scab may occur on the lower surfaces of leaves, forming poorly defined, light green to brownish patches on the blade, midrib, and stem, but it causes no injury of consequence.

As compared with most seedlings, the named varieties of commercial importance show a marked resistance to scab, but differences in the susceptibility or resistance of commercial varieties are not great. In general, however, the later varieties are more subject to the disease, presumably because they are subjected to a longer exposure. Heath, Salwey, and Bilyeu are considered more susceptible than Elberta, and the latter is considered more susceptible than Carman, Hiley, or Belle.

PREVENTIVE MEASURES

REMOVING SOURCES OF INFECTION

It might be supposed that the removal of rotted fruits, cankers, and dead twigs from the orchard would prevent the occurrence of brown rot during the following year. Although this procedure is an aid in controlling the disease, it cannot be relied upon as the only means of control, because (1) it is not possible to remove all the sources of infection, and (2) the spores may be blown into the orchard from outside sources.

Cleaning up, however, does materially reduce the sources of infection and probably is of great value in preventing blossom blight, which is generally caused by spores from mummies. As has been pointed out, the blighted blossoms and ensuing cankers are important in carrying the disease over to the ripening fruit; therefore the prevention of blossom blight not only saves the blossoms but reduces the sources of later infection as well.

Probably the best time for removing the rotted fruits from the tree is directly after picking time, since at that time they have not shrunk in size so much as to be easily missed. At that time, too, the fungus frequently has not grown down the stems of the fruits and infected twigs. The mixing of sound and rotted fruit at picking time should be avoided insofar as practicable, because contact of the rotted with the sound fruit increases the liability of the latter to rot. Mummied fruits on the ground may be gathered up or plowed under. The latter method is probably the better one, since the half-buried mummies, which produce the goblet-shaped fruiting bodies most abundantly, are easily missed in gathering, and they are effectively disposed of by plowing. The completely buried mummies are rapidly disintegrated by the action of micro-organisms.

The cankers and dead twigs appear to be unimportant as sources of infection, except perhaps in the humid sections close to the Atlantic coast. The removal of cankers is not practicable, and the removal of dead twigs should be incidental to the usual pruning operations.

Although the removal of mummified fruits helps to control brown rot, it is of no importance in the control of scab, and the pruning out of twigs infected with scab is neither practicable nor necessary.

THINNING THE FRUITS

Thinning the fruits of heavily laden trees prevents the fruits from coming into contact with one another. If one of two peaches which touch each other rots, the other is almost certain to do so, the rot starting at the point of contact. Fruits which are close together, and especially those in contact with one another, can be covered with sprays or dust only with the greatest difficulty.

SPRAYING AND DUSTING

The principal method of controlling brown rot and scab is the application of sprays or dusts to the trees at certain times during the growing season. In seasons favorable to the development of brown rot and scab, thorough applications of the correct spray or dust, made at the right times, often mean the difference between a crop of clean fruit and no crop at all. In addition, the sprayed or dusted fruit is less subject to brown rot after picking, in transit, and on the market.

Previous to 1907 bordeaux mixture was used to some extent as a spray for peaches, but it was so injurious that it cannot be recommended. In 1907 W. M. Scott, of the United States Department of Agriculture, discovered that a mixture of sulphur, lime, and water, since known as self-boiled lime-sulphur, could be used on peach trees, either alone or in combination with arsenate of lead, with little risk of injury and with excellent results in the control of brown rot and scab. This mixture and similar ones are now in general use as fungicides for the control of these diseases.

Spraying should be done carefully with fine nozzles and with a pressure of at least 200 pounds. The spray should be shot through the tree from two opposite sides, in order to cover the entire surface of the fruits. Care should be taken not to overspray, especially when arsenate of lead is an ingredient of the spray, as the leaves, fruit, and young twigs are easily injured by an excess of this material. In all applications the spray should be in the form of a fine mist. Such a spray covers well, decreases the risk of injury, and is desirable in the last application to prevent the formation of splotches which keep the fruit from coloring properly and may leave undesirable residues on the picked fruit.

After the spraying apparatus has been used for the application of self-boiled lime-sulphur or any of its substitutes it should be thoroughly cleansed, as all these mixtures on drying set almost as hard as cement. The quantity of spray fluid required to cover a peach tree ranges from about half a gallon to 4 gallons, depending on the size of the tree and the apparatus used. The average is probably somewhat less than 2 gallons.

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With the advent of finely ground sulphur about 1912, dusting with sulphur, a practice which had formerly been ineffective on account of the coarseness of the grains of sulphur, again came into use. It was found that the finely divided sulphur could be mixed with finely powdered arsenate of lead and hydrated lime to form a combined fungicide and insecticide. Scab is controlled at least as well with dust as with the liquid spray and in many cases more completely. It is probable that in very moist seasons requiring a maximum of effectiveness spraying would be somewhat superior to dusting for the control of brown rot. On the other hand, applications of dust can be made later in the season than sprays without much risk of preventing the fruit from coloring properly or of leaving undesirable residues. Dust, being more easily and more quickly applied, is more saving of labor. It is less liable than the sprays to cause injury.

When using dust it is essential to proceed along each row of trees, dusting the near side of each tree. It is practically impossible to obtain satisfactory results by dusting across the spaces between the rows. The quantity of dust required to cover a peach tree of average size is about one-fourth pound.

Whether spray or dust is used, growers in all sections where brown rot and scab occur should make the applications according to schedule. They should not lessen their efforts during a season following one in which the diseases have not been serious.

SPRAYING AND DUSTING SCHEDULES

For the control of brown rot, scab, and curculio [1] in the eastern half of the United States, except the humid sections of the Southeast including Georgia and the Gulf States, the following schedule is recommended.

FIRST APPLICATION

When calyces or "shucks" are being shed, which is usually about 10 days after the falling of the petals—

Spray: Powdered arsenate of lead, 1 pound (or 2 pounds of the paste) and the milk of lime from 3 pounds of stone lime or 4 pounds of hydrated lime with water sufficient to make 50 gallons; or

Dust: (1) Hydrated lime 95 percent, arsenate of lead 5 percent; or (2) sulphur 80 percent, arsenate of lead 5 percent, hydrated lime 15 percent.

SECOND APPLICATION

Two weeks after the first application, or about 4 weeks after the petals have fallen—

Spray: Self-boiled lime-sulphur 8–8–50 (or substitute), to each 50 gallons of which 1 pound of powdered arsenate of lead (or 2 pounds of the paste) is added; or

Dust: Sulphur 80 percent, arsenate of lead 5 percent, hydrated lime 15 percent.

THIRD APPLICATION

One month before each variety is expected to ripen—

Spray: Self-boiled lime sulphur 8–8–50 (or substitute) without the addition of arsenate of lead; or

Dust: (1) Sulphur 80 percent, hydrated lime 20 percent.

[1] Directions for the use of arsenate of lead in the control of the curculio were furnished by the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

This schedule is for early and midseason varieties. For varieties later than Elberta an additional application of self-boiled lime-sulphur or one of its substitutes should be made about 4 weeks after the second application. The first application is primarily for the control of the curculio, the second is primarily for the control of scab and curculio, and the third is primarily for the control of brown rot. The additional application on late varieties is primarily for the control of scab. Some growers prefer to use in the first application self-boiled lime-sulphur (or a substitute) or a dust containing sulphur. There is no objection to such a procedure, but it is considered unnecessary.

For southeastern United States, including Georgia and the Gulf States, the following schedule is recommended.[2]

FIRST APPLICATION

Immediately after 75 percent of the petals have fallen—
Spray: Powdered arsenate of lead 1 pound (or 2 pounds of the paste) and the milk of lime from 3 pounds of stone lime or 4 pounds of hydrated lime with water sufficient to make 50 gallons; or
Dust: (1) Hydrated lime 95 percent, arsenate of lead 5 percent; or (2) sulphur 80 percent, arsenate of lead 5 percent, hydrated lime 15 percent.

SECOND APPLICATION

When calyces or "shucks" are being shed, which is usually about 10 days after the falling of the petals—
Spray: Same as for first application; or
Dust: Same as for first application.

THIRD APPLICATION

Two weeks after the second application, or about 4 weeks after the first application—
Spray: Self-boiled lime-sulphur 8–8–50 (or substitute); or
Dust: (1) Sulphur 80 percent, hydrated lime 20 percent; or (2) sulphur 80 percent, arsenate of lead 5 percent, hydrated lime 15 percent.

FOURTH APPLICATION

One month before each variety is expected to ripen—
Spray: Self-boiled lime-sulphur 8–8–50 (or substitute), to each 50 gallons of which 1 pound of powdered arsenate of lead (or 2 pounds of the paste) is added; or
Dust: Sulphur 80 percent, arsenate of lead 5 percent, hydrated lime 15 percent.

This schedule is for early and midseason varieties. For varieties later than Elberta an additional application of self-boiled lime-sulphur or one of its substitutes should be made about 4 weeks after the third application. The first and second applications are primarily for control of curculio, the third is primarily for the control of scab, and the fourth is primarily for the control of curculio and brown rot. The additional application on late varieties is primarily for the control of scab. Some growers prefer to use in the first two applications self-boiled lime-sulphur (or a substitute) or a dust containing sulphur. There is no objection to such a procedure, but it is considered unnecessary.

[2] See also Farmers' Bulletin 1557, Insects Attacking the Peach in the South and How to Control Them.

PREVENTION OF ARSENICAL INJURY

Occasionally sprays containing arsenate of lead may cause severe injury to leaves, twigs, and fruits of the peach. These injuries may be greatly lessened by adding 4 pounds of zinc sulphate to each 50 gallons of any of the above-mentioned sprays containing arsenate of lead and lime or arsenate of lead, lime, and sulphur, or by adding the required amount of arsenate of lead to the spray hereinafter called zinc-lime. *Zinc sulphate should never be used without an equal quantity of lime.*

ADDITIONAL APPLICATIONS

FOR CONTROL OF BROWN ROT ON THE FRUIT

An additional application of dust (sulphur 100 percent, or sulphur 80 percent and hydrated lime 20 percent) may be made within a week of the time the fruit is expected to ripen. This application may be of use in preventing brown rot on the fruit, both on the tree and after it is picked, especially during a wet season. The dusting should be very lightly done, in order to avoid residues on the picked fruit. A light application of one of the commercial substitutes for self-boiled lime-sulphur which contains little or no lime may also be made at this time. If only a light application is made, the weather and the ordinary handling of the fruit should remove all noticeable traces of the dust or spray. In any event, no fruit should be offered for sale which shows noticeable residues of dust or spray, no matter how harmless the residues may be.

FOR CONTROL OF BLOSSOM BLIGHT

The writers have not been very successful in controlling blossom blight in the South by applying spray at the time the blossoms are showing pink (just before they open). The Maryland Agricultural Experiment Station has reported excellent results in Maryland orchards from an application of self-boiled lime-sulphur or of the sulphur, hydrated lime, and casein mixture (dry mix) made at that time. In localities where blossom blight is regularly destructive an application of one of the sulphur sprays herein described, when about 20 percent of the blossoms are out, is worthy of trial.

SPRAY RESIDUES

The proper application of sprays in accordance with the regular schedule should not result in any residues of lead arsenate in injurious quantities. The last application containing lead arsenate should not be excessively heavy, and it is very important that no lead arsenate be applied later than 4 weeks before the probable ripening date of the variety being sprayed. It should be noted that the additional applications suggested are of the harmless chemicals, sulphur and lime, without the lead arsenate. In view of the keen attention now being given to spray residues remaining on fruit on the market, the grower is cautioned not to use lead arsenate in any of these later applications. Rains and weathering usually remove objectionable spray residues on peaches grown in the humid eastern United States; yet

in any section where curculio and brown rot necessitate the foregoing spraying and dusting schedules, peaches should not be eaten or offered for sale unless they are known to be free from even invisible lead arsenate residues. If excessive residues of lead arsenate are present the harvested fruit should be run through a brushing machine which removes much of the residue.

SPRAY MIXTURES

SELF-BOILED LIME-SULPHUR MIXTURE

The mixture of milk of lime, sulphur, and water known as self-boiled lime-sulphur was the first fungicide which could be sprayed on the peach without risk of severe injury and could at the same time control brown rot and scab. For the control of brown rot and scab of the peach it has not been surpassed by the newer sulphur sprays designed as substitutes for it, and it is less liable to cause injury than any of the substitutes yet developed.

The formula for the standard mixture is as follows:

Sulphur (flowers, flour, or "commercial ground")	pounds	8
Stone lime	do	8
Water	gallons	50

The preparation of the mixture is facilitated by making it up in fairly large quantities, at least enough for 200 gallons of spray, but it can be made up in very small quantities.

The lime should be placed in a barrel and enough water added nearly to cover it. If the lime is found not to slake readily in cold water, hot water should be used. With sluggish lime it is also well to cover the barrel with sacks or heavy cloth of some kind to prevent the escape of the heat. As soon as the slaking of the lime is well under way, the sulphur, first passed through a sieve to break up the lumps, should be added. If the sulphur is stirred into a small quantity of water before it is added it will be more evenly distributed and more easily worked into the lime. After the addition of the sulphur the mixtures should be constantly stirred and more water added from time to time as needed to form at first a thick and then gradually a thin paste. The lime should supply enough heat to boil the mixture several minutes. As soon as slaking has ceased, water should be added to cool the mixture and prevent further cooking. The mixture is then ready to be strained into the spray tank, diluted, and applied.

The stage at which water should be added to cool the mixture varies with different limes. Some limes slake so slowly that it is difficult to obtain sufficient heat from them, while others become intensely hot on slaking and cause the mixture to boil violently. Care should be taken, especially with rapidly slaking limes, not to allow the boiling to last too long. If the mixture is allowed to remain hot for 15 or 20 minutes after slaking is completed, some of the sulphur combines with some of the lime to form sulphides which are injurious to peach foliage. The presence of these sulphides is indicated by the appearance of reddish-brown streaks in the mixture. When these begin to appear it is a sign that the mixture should be cooled at once. If rapidly slaking lime is used, it is espe-

cially important to cool the mixture quickly by adding a few bucketfuls of water as soon as the lime has slaked. The final product is a uniform lemon-colored mixture of finely divided sulphur and lime, with only a very small percentage of the sulphur in solution. The mixture should be strained to take out the coarse particles of lime, but the sulphur should be carefully worked through the strainer. Good agitation of the spray after it is placed in the tank is essential to prevent settling.

SUBSTITUTES FOR THE SELF-BOILED LIME-SULPHUR MIXTURE

SULPHUR AND HYDRATED-LIME MIXTURE

The sulphur and hydrated-lime mixture, devised by G. C. Starcher, of the Virginia Agricultural Experiment Station, as a substitute for self-boiled lime-sulphur, is made by using hydrated lime in place of stone lime, the necessary heat being supplied by boiling water. The formula is as follows:

Sulphur (flowers, flour, or "commercial ground")	pounds	8
Hydrated lime (fresh)	do	8
Boiling water	gallons	8
Finally, cold water to make	do	50

The sulphur and the hydrated lime should be mixed together dry and then passed through a sieve. Place the dry mixture in a barrel or other suitable container and add the boiling water. Stir for 5 minutes and then add sufficient cold water to cool the mixture thoroughly. Run through a strainer into the tank previously filled with sufficient water to make the required quantity. Do not allow the boiling water to act for more than 5 minutes. The resulting spray fluid must be kept well agitated.

SULPHUR, HYDRATED-LIME, AND GLUE MIXTURE

The sulphur, hydrated-lime, and glue mixture is a substitute for self-boiled lime-sulphur in which the suspension of the sulphur and lime is effected through the presence of a colloidal substance, glue, which forms with sulphur and lime a mixture that takes up water readily. The formula is as follows:

Sulphur (finely ground flour or flowers)	pounds	8
Hydrated lime (fresh)	do	8
Ground glue	ounces	2
Water to make	gallons	50

The glue (common ground glue obtainable at drug stores) should be dissolved in a small quantity of hot water and then diluted with sufficient water to make about 4 gallons. Mix the sulphur—preferably the so-called dusting sulphur—and the lime together thoroughly and pass the mixture through a sieve. Place the mixture in a barrel or other suitable container and slowly add the glue solution, stirring the mixture vigorously. After the ingredients have been well mixed, add water slowly, with continuous stirring, until a mixture of the consistency of thin paint is obtained. Strain this into the spray tank, which should contain sufficient water to make the required quantity, and keep the mixture well agitated. If arsenate of lead

is not to be used with the mixture, the quantity of lime may be reduced one-half if desired.

SULPHUR, HYDRATED-LIME, AND CASEIN MIXTURE

The sulphur, hydrated-lime and casein mixture is commonly known as "dry mix" and is a substitute for the self-boiled lime-sulphur. It is similar to the sulphur, hydrated-lime, and glue mixture. The hydrated lime takes the place of the stone lime used in the self-boiled lime-sulphur, and the casein takes the place of heat in bringing about a suspension of the ingredients in water. The following formula is recommended:

Sulphur (finely ground flour or flowers)	pounds	8
Hydrated lime (fresh)	do	8
Casein-lime (mixture)	do	½
or		
Casein	do	¼
Water to make	gallons	50

The finely divided "dusting sulphur" should be used. Casein-lime may be purchased ready prepared, under various trade names. The lime and the sulphur should be passed through a sieve to remove any lumps. All three ingredients should then be thoroughly mixed together dry. Water should be added slowly with continuous stirring until the mixture is of the consistency of thin paint. It should then be added to the required quantity of water in the spray tank.

The quantity of lime may be reduced one-half, if desired, when arsenate of lead is not added to the spray. One would then be following the formula of A. J. Farley, of the New Jersey Agricultural Experiment Station. Most of the ready-mixed sulphur-hydrated lime-casein mixtures which are sold on the market under various trade names are made up according to Farley's formula. When such mixtures are used with arsenate of lead, about 4 pounds of hydrated lime should be added to each 50 gallons of spray to lessen the risk of injury.

SULPHUR, HYDRATED-LIME, AND SKIM-MILK MIXTURE

R. H. Robinson, of the Oregon Agricultural Experiment Station, has suggested a mixture made up as follows:

Sulphur (superfine flour)	pounds	8
Hydrated lime	do	4
Skim milk	quarts	2
Water to make	gallons	50

The sulphur should be the so-called dusting sulphur. If skim milk is not available, whole milk may be used. Milk only slightly sour may be used. Mix the sulphur and the lime. Add 2 quarts of water to the 2 quarts of milk and stir into it the sulphur and lime. Add more water as the paste becomes thick. Finally, add several gallons and pass the fluid through a strainer into the spray tank. Add the required quantity of water, or, better still, have it already in the tank.

This mixture has not been tried by the writers, and accordingly they are unable to judge its merits. When used with arsenate of lead, the mixture would probably be less liable to cause injury if the quantity of lime in the foregoing formula were doubled.

COMMERCIAL SUBSTITUTES FOR SELF-BOILED LIME-SULPHUR

Numerous substitutes for self-boiled lime-sulphur are on the market. Some of them are composed principally of sulphur in colloidal form, and others are pastes or powders containing finely divided sulphur, lime, and a colloidal substance such as glue or casein to make the mixture stay in suspension in water. When used with arsenate of lead, most of them require the addition of at least 4 pounds of hydrated lime to each 50 gallons of spray, in order to lessen the risk of injury. When no arsenic is used, it is not necessary to add lime. In buying commercial substitutes for self-boiled lime-sulphur, growers should be sure that they are not getting substitutes for the better-known and more widely used lime-sulphur solution, which is recommended for use on the peach only during the dormant season. When mixed with water the latter forms a clear reddish-brown solution, the former a lemon-colored or milky fluid.

ARSENATE OF LEAD

Arsenate of lead in powdered or paste form can be obtained from dealers in spray supplies. At the present time the powdered form is used more generally than the paste. Arsenate of lead should be the last ingredient added to the spray mixture and should be thoroughly mixed with sufficient water to form a thin paste before it is poured in.

ZINC-LIME

The following formula is recommended for the zinc-lime spray, but the proportions of zinc sulphate and hydrated lime to water may be increased up to 8–8–50 if desired, without causing injury. However, proportionately better results have not followed the use of a zinc-lime spray stronger than the one here recommended.

Zinc sulphate	pounds	4
Hydrated lime (fresh)	do	4
Water	gallons	50

Zinc sulphate ($ZnSO_4.7\,H_2O$), sometimes called granular zinc sulphate or white vitriol, is a common chemical easily obtained through wholesalers and jobbers. A so-called anhydrous zinc sulphate is sometimes found on the market. This product is not anhydrous (free from water), but contains, in varying quantities, less water than the granular zinc sulphate and is more easily handled because it is relatively free of lumps. For practical purposes, 3 pounds of the so-called anhydrous zinc sulphate may be considered equal to 4 pounds of the ordinary granular zinc sulphate, provided it is stored in a dry place and kept well-covered so that it does not absorb water. Zinc sulphate may be obtained in a flake as well as in a crystalline form.

PREPARATION OF THE SPRAY

Fill the tank nearly full of water. Start the engine to agitate the spray materials. Add zinc sulphate, which, if the lumps are well broken up, will dissolve in less than 5 minutes. After it has dissolved, the lime mixed with a small quantity of water to form a thin paste should be washed through the strainer into the tank. Finish filling the tank and agitate for 5 minutes or more before beginning to spray.

The white precipitate settles somewhat rapidly when there is no agitation, but it is easily kept in suspension by agitation. Use at once.

Zinc-lime is the safest and most effective spray developed for the control of peach bacterial spot caused by *Bacterium pruni* E. F. S. For the control of that disease, six or seven applications at 2-week intervals, beginning at petal fall, are necessary.

DUSTS

For use on peaches the following mixtures of dust are recommended:

(1) Sulphur 80 percent, arsenate of lead 5 percent, hydrated lime 15 percent.
(2) Sulphur 80 percent, hydrated lime 20 percent; or sulphur 100 percent.
(3) Hydrated lime 95 percent, arsenate of lead 5 percent.

Formula no. 1 should be used in applications requiring both sulphur and arsenate of lead. If desired, it may be used in all applications made not later than 1 month before the fruit is expected to ripen.

Formula no. 2 is for the late applications from which arsenate of lead is omitted.

Formula no. 3 is for the early applications in which the spraying schedule does not call for sulphur.

The materials should be very finely divided and especially made for dusting purposes. They may be mixed at home or if desired may be bought ready mixed. Small quantities may be mixed with a shovel or a hoe, but care should be taken to make the mixture uniform. There are a number of homemade contrivances similar to cement mixers which appear to mix the ingredients effectively. For handling large quantities, very efficient mixing machines may be purchased.

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